original three. All were grouped together under the rubric Indo-European, and their family tree traced back to an ancient tongue spoken perhaps 8,000 years ago. It took another century for scholars—including the brothers Grimm of fairy tale fame—to painstakingly reconstruct that lost language.

That was hardly the end of the matter. As early as 1903, a Danish linguist named Holger Pedersen noted vague similarities between Indo-European and other proto-languages, including Semitic (precursor of Arabic and Hebrew) and Altaic (ancestor of Japanese and Korean). But it was not until 1964 that two Soviet scholars, Vladislav Illich-Svitych and Aaron Dolgopolsky, were able to reconstruct (separately) a single ancestral tongue called Nostratic, a tribal language that they believe was spoken some 14,000 years ago.

Nostratic, in turn, may be only one of several language "phyla": The others are Sino-Caucasian, Australian, Khoisan, Indo-Pacific, Austric, and Amerind.

During the last 10 years, Sheveroshkin and others, now aided by computers, have compared the different proto-languages to reconstruct proto-World. Actually, he says, dating proto-World has been harder than reconstructing it. Based on recent studies by geneticists, research on ancient migratory patterns, and archaeological evidence, backers of the proto-World theory concluded that the language is close to 100,000 years old.

What does their language tell us about our ancestors? They were truly people of few words and spared none for description of the emotions. Unsurprisingly, the most common word was *ngai* ("I"). And, apparently, they were bothered by many of the same things that bother us, for they took the trouble to invent words for fleas, lice, and in-laws.

The Importance of Genes

"We cannot continue to think about disease as an outside enemy," geneticist P. A. Baird argues in *Perspectives in Biology and Medicine* (Winter 1990). The enemy is now us. Baird favors a "paradigm shift" in medicine, replacing the "war" against disease with efforts to detect and prevent genetic maladies.

The relative contribution of genetic causes to all causes of disease in our population has likely increased markedly in this century for many disorders. For example, in the early years of the century the infant mortality rate in the United States was about 150 per 1,000 live births. It is estimated that about five of these 150 deaths, or three percent, were due to a wholly or partly genetic cause. Nowadays the infant mortality rate is closer to 15 per 1,000 live births. However, the five are still there in the genetic category; but, instead of constituting three percent, they constitute over one third of all infant deaths .... In the 1920s the role of vitamin D [in rickets] was elucidated, and food supplementation by vitamin D on a population basis was initiated. The incidence of rickets declined dramatically, but cases continue to appear. However, instead of being environmentally caused, rickets [sufferers] now have inherited genes giving a disorder of mineral metabolism—rickets—even when normal amounts of vitamin D are present. The heritability of rickets is now very high, and these cases need lifelong care.

Killer Chlorophyll

"Making, Breaking, and Remaking Chlorophyll" by George Hendry, in *Natural History* (May 1990), Central Park West at 79th St., New York, N.Y. 10024.

If you were asked to name the most dangerous substances known to man, chlorophyll probably would not come immediately to mind.

One reason we are not aware of its potential hazards, writes Hendry, a researcher at the University of Sheffield, is that nature has devised elaborate means to contain them. The autumnal glories of a Vermont sugar maple are partly the result of chlorophyll's programmed suicide. In the world's oceans, nature condemns chlorophyll in single-celled marine phytoplankton to a half-life as short as 48 hours. (A half-life is the time it takes for half of the substance to be transformed or degraded.) Overall, the world stock of chlorophyll is close to 250 million tons, and it is turned over 3.7 times each year.

There are several reasons why nature allows this seemingly senseless slaughter. But an important reason has to do with the process of photosynthesis.

As Hendry explains, the chlorophyll molecule can be thought of chiefly as a provider of electrons. Each molecule is surrounded by a cloud of orbiting electrons; when struck by sunlight, the molecule resonates and one of the electrons is flipped out of orbit "along an electrical circuit to drive the production of storable chemical power." Occasionally, however, there is a malfunction, and the electron escapes and attaches itself to an oxygen molecule. The result is an "oxygen radical," one of which, the hydroxyl radical (HO), is a kind of terrorist of the natural world. It "almost instantly abstracts hydrogen from any convenient neighboring molecule, thereby destroying the structure of many organic molecules."

Even animals can be affected. In a rare disorder among sheep called geldikkop, partly digested chlorophyll passes into the bloodstream; sunlight striking the skin causes the chlorophyll to produce oxygen radicals, and the animal to suffer lesions.

Normal malfunctions of photosynthesis are policed by the plant's antioxidants—such as ascorbic acid (vitamin C) and tocopherols (vitamin E)—which also happen to be beneficial to humans. But drought or cold weather triggers malfunctions on a huge scale. As autumn nears in New England, then, nature orchestrates the mass suicide of chlorophyll to prevent an invasion of oxygen radicals, which would disrupt the all-important process of salvaging carbohydrates, proteins, and other useful compounds from the plants' leaves.

This elaborate fail-safe device, Hendry says, allows nature's leafy "solar panels" to operate "with an efficiency and safety record unmatched by anything humans have yet devised."

Big Business, Big Science

"The Scientific Tradition in American Industrial Research" by John Kenly Smith, Jr., in *Technology and Culture* (Jan. 1990), National Museum of American History, Room 5030, Smithsonian Inst., Washington, D.C. 20560.

The brash young pioneers of California's Silicon Valley have revived the dream of the swashbuckling American inventor, freed at last from the shackles of big business. There is indeed something new happening in the relationship between science and business, writes Smith, a historian at Lehigh University, but Silicon Valley exemplifies the past, not the future.

That relationship began during the 1870s and blossomed into marriage because of new competitive pressures on big business generated by the expiration of many old patents and by the federal government's vigorous antitrust efforts. By World War I, the pioneers of U.S. industrial research—General Electric, DuPont, AT&T, and Kodak—had all established their own laboratories to help them maintain market share.

At first, Smith says, "American industries cast a wide net for new technologies but in general did not expect to invent them. Rather, they made use of the work of independent inventors." That strategy was a success, producing such technological and marketplace triumphs as cellophane (DuPont), refrigerators (GE), and color film (Kodak).

By the 1930s, however, several corporate laboratories were beginning to change: "Instead of just applying science, industrial researchers would 'do' science," Smith notes. This kind of basic research led to the creation of nylon at DuPont in 1934 and of the transistor at AT&T in